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(54) WOOD FLOORING SYSTEM

(71) I, RAY EDWARD OMHOLT, a citizen of the United States of America, of Mid-Atlantic Park, 590 Grove Road, Thorofare, New Jersey 08086, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the field of wood flooring systems of the type wherein a supporting base is covered with an adhesive-applied wooden floor. Such systems are in common use in gymnasiums, pavilions, shopping centres, airports, office buildings, and the like.

Such wood floors require a flat upper surface with essentially no openings between boards to achieve a desirable appearance and to minimize maintenance. Such floors must also withstand heavy use without buckling, warping, or forming other surface irregularities. In addition, the floor should ideally be provided with a uniform cushioned support to help prevent fatigue from prolonged walking such as in shopping centres, as well as to reduce athletic injuries such as the shin splints experienced by basketball players. The stability, planarity, and resilient cushioning of the floor are essential for providing an economical and uniformly comfortable wood flooring system which has an excellent appearance.

Wooden floor members are normally installed at a controlled moisture content of approximately 7% to 8%. After installation, and during dry cold winter seasons when room temperature is maintained at approximately 70°F., the moisture content of the wooden floor members may drop to approximately 5% to 6%, and this can cause minor shrinkage of the wooden floor members. However, a drop in moisture content of less than 3% normally causes only minor shrinkage within wooden floor members. Since open cracks of 1/32″ or more between wooden floor members are visually objectionable and provide dirt traps which substantially increase maintenance, an upper installation moisture content of 8% is normally adhered to in geographical areas requiring artificial heat during winter months.

During spring, summer, and autumn months, humidity and condensation conditions are much more aggravated than they are in winter months and normally increase the moisture content of the wooden floor members above the level at which they were installed. This gives rise to expansion forces within the wooden floor members. These forces are directly related to the increased moisture content of the wooden floor members. A moisture content of 9% to 12% in the wooden floor members is not unusual during summer months, and the moisture content can go as high as 27-30% if the wooden floor members are flooded inadvertently, a not-too-uncommon occurrence caused by breaks in hot water heating systems, sewer back-ups, etc.

As the moisture content of wooden floor members increases above the moisture content at the time of installation, the wooden floor members expand if permitted to do so. If unrestricted lateral expansion is permitted, large undesirable shrinkage cracks may appear between the wooden floor members during the following dry season. If lateral expansion is limited, such as by perimeter walls, or by the gripping and tensile strength of the adhesive, the lateral expansion force translates itself into a vertical lifting force. Buckling is defined as the condition which exists when a wooden floor system separates itself vertically from the supporting base. Depending on the type of adhesive-applied wood flooring system being considered, such buckles can

rise as much as 18" above the normal floor surface.

In a restricted-growth, adhesive-applied wooden floor system, it is, therefore, necessary for the adhesive not only to restrict the lateral growth of wooden floor membersd uring periods of increased moisture content, but it is necessary to restrict potential vertical displacement of the wooden floor members with a force in excess of the vertical buckling forces developing within the wooden floor system.

If a wooden floor system is to maintain an essentially monolithic appearance during normal moisture change cycles, therefore, it is desirable that it be installed at a moisture content approximately 3 moisture content percentage points higher than the lowest average level which is anticipated during dry winter months; and it is further necessary that the adhesive securing the wooden floor members to the supporting base has sufficient gripping and tensile strength to control the expansion and buckling forces which exist during damper periods of the year.

Prior flooring systems wherein wood members were adhesively secured to the supporting base do not combine, by use of adhesive alone, elastomeric resilient cushioned response with a high resistance to movement and buckling caused by stresses induced by moisture in the wooden flooring members. Most frequently, problems arose as a result of adhesives that could not bridge an uneven supporting base, the use of adhesives which did not hold well, and adhesives which did not provide cushioned resiliency to the floor system. The prior art adhesives, often asphalt emulsions, asphalt cutbacks, epoxies, polyvinyl acetates, or solvent based rubbers, lacked the combination of high holding power to both wood and concrete in combination with cushioned resiliency. Additionally, some were difficult to apply and had short working times before they set. None provided a resilient cushioning effect.

Several attempts have been made to solve these problems. Elmendorf in U.S. patent 2.018,711 uses a non-cushioned adhesive and provides for appreciable expansion between the flooring members. Accordingly, Elmendorf fails to achieve a restricted-growth and resiliently cushioned wood floor system.

Other adhesive-applied flooring systems use rigid adhesives which may limit the movement of the wood flooring members, but they fail to provide resilient cushioning in the adhesive.

Other adhesive-applied wood flooring systems are able to achieve resilient cushioning by use of a cushioning non-adhesive layer spaced between the base and the flooring boards, but these systems failed to tightly grip and retain the floor boards in their desired disposition so that moisture-induced forces on floor boards which have little or no provision for expansion between adjacent boards can be overcome without permitting the floor system to buckle or expand.

As a result of the foregoing, consumers wanting an adhesive-applied wood flooring system applied directly to a support base have been required to select either a rigidly restrained non-cushioned adhesive-applied system, or an adhesive-applied cushioned system without positive restraint.

Other U.S. patents teach various composite flooring systems including Marino, U.S. patent 3,365,850; Bartolini, U.S. patent 3,521,418; and Munro, U.S. patent 1,250,623. In each of these patents, the floor boards are separated by spaces, the spaces being filled with some type of relatively easily compressible material. The flooring systems of each do not combine, by use of adhesive alone, resilient cushioning and positive restraint of individual board members.

The improved flooring system described below overcomes these deficiencies and provides a flooring system having uniform planarity, an essentially monolithic surface, cushioned resilience, great stability, and the ability to accommodate a relatively uneven support base.

As contrasted with prior art low-pressure-between-board systems which are designed to permit board growth and movement, the present invention provides for lateral and vertical restraint of wood floor members even during periods of high moisture content with resultant expansion forces within the floor system. It does this while simultaneously providing resilient cushioning.

In accordance with the invention there is provided a method of installing a restricted-growth resiliently cushioned adhesive-applied wood flooring system over a supporting base comprising the steps of:

coating the base and/or the bottom surfaces of wooden flooring members having top and bottom surfaces and side edges with an adhesive material which is elastomeric when cured;

pressing said wooden members on to the base with the adhesive material therebetween to form a wood/adhesive material/base material sandwich with just two interfaces and with said adhesive material contacting substantially the entire bottom surface of the wooden members;

and permitting the adhesive material to cure to a condition wherein it forms a resilient cushioning elastomeric bond between the wooden members and the base and has sufficient gripping and tensile

strength to overcome potential buckling forces generated within said wooden members as a result of adverse moisture conditions without sacrificing the cushioning properties of the system as laid.

Also in accordance with the invention there is provided a restricted-growth resiliently cushioned adhesive-applied wood flooring system installed by the method in accordance with the invention, the flooring system comprising a supporting base, wooden flooring members, and an elastomeric resilient cushioning adhesive material between said base and said wooden flooring members, said wooden flooring members being spaced from said base by said adhesive material, said wooden members each having side edges, a top surface and a bottom surface, said wooden members being elastomerically bonded into said adhesive material with said material contacting substantially all the base and the bottom surfaces of said wooden members, said adhesive material having sufficient gripping and tensile strength to overcome potential buckling forces generated within said wood flooring system as a result of adverse moisture conditions without sacrificing the cushioning properties of the system as laid.

A resilient cushioning adhesive, such as a two-component polyurethane, which is elastomeric when cured is provided between the wooden flooring members and the supporting base such as concrete, plywood, or the like.

When the wooden flooring members are placed on the uncured adhesive and pressed into the adhesive, the adhesive achieves substantially intimate contact with the bottom of the wood flooring members. Being waterproof in nature, the adhesive thus seals the bottoms of the wood flooring members. This greatly aids in controlling the warpage phenomena known as "cupping" which occurs when bottoms of boards have a higher moisture content than tops of boards. Additionally, the adhesive, after it is cured, provides a bond of high strength between the flooring members and the supporting base. The flooring system, as thus described, is termed a restricted growth flooring system because essentially no lateral or upward buckling movement of the floor boards is permitted, even during periods of moisture-induced high stress. Further, when the adhesive provides an adequately thick continuous layer of material over the base, earth water vapour which could otherwise come through the base, when the base is on or below ground level or over a swimming pool, and introduce moisture into the wood flooring members, is prevented from penetrating to the wooden floor. Naturally, the thicker the continuous layer of adhesive, the more effective it will be in preventing water vapour from reaching the floor boards.

While the use of a free-flowing liquid polyurethane material is possible, such a free-flowing liquid material makes it difficult to control the installation of the floor boards which tend initially to skid in the material, and it is expensive to use, specifically over an uneven base. Accordingly, in the preferred embodiment I use a polyurethane material which is sufficiently thickened that it can be trowelled on to the supporting base in the desired adhesive ridge configuration. The trowell-ability of the adhesive material may be achieved by the addition of approximately two parts by volume of powdered filler such as fumed colloidal silicon dioxide to one part of liquid. Additionally, the final average cushioning thickness of the adhesive can be predetermined and achieved by controlling various factors including the configuration or amount of the material applied to the base and the amount and duration of the weight applied to the floor boards.

A suitable two-component polyurethane material is sold by Powerlock Systems, Inc. under the trademark "Versaturf 360".

By trowelling the material, the usage of the material is maintained at a minimum, thereby controlling the adhesive cost of the flooring system. Further, the trowelled material exerts an initial grabbing force on the wooden floor members set into the trowellable material. In contrast to using a flowable liquid which spreads and initially fills the lowest areas in the base, the trowellable material maintains a substantially uniform thickness over the base, even if the base is uneven. In addition, less labour is required to effect trowelling, and trowelling permits completion of isolated sections of the floor at a rate which can be set by the worker.

The trowelling tool is preferably provided with an edge serration pattern which provides a ridged pattern for the adhesive material on the supporting base. The ridges are spaced from each other and are wider at the base than at the top thereof. In the preferred embodiment, the ridges are approximately three-sixteenths inch wide at the base, are approximately one-quarter inch high, and are spaced from one another by approximately three-sixteenths inch. However, the trowelling tool will apply a very thin layer of the adhesive between adjacent ridges. As the boards are pressed into the ridges, the adhesive material is compressed and substantially fills the space between the boards and the base to a substantially uniform predetermined thickness of approximately one-sixteenth. Naturally, the foregoing dimen-

sions can be modified depending upon the degree of resilient cushioning required for the floor. Depending upon the pressure applied to the top of the floor boards, slight gaps may exist between adjacent flattened ridges or adhesive. However, when the base is at or below ground level it is preferred that no slight gaps exist.

Additionally, the durometer of the resilient cushioning adhesive can be varied between 30 and 80 using a Shore A-2 hardness scale as a guide to secure the desired degree of cushioning, depending on the specific usage intended. The lower range of the scale is more desirable for walking and athletic activities, and the upper range of the scale is more suitable for heavy commercial usage such as in bakeries and newspaper plants.

The foregoing disclosed embodiments are preferred since the floor obtained thereby has excellent properties and involves a minimum of cost from a labour and material standpoint.

Various powdered fillers such as silicon dioxide, sold under the Registered Trademark "CAB-O-SIL" by Cabot Laboratories, can be used for thickening the liquid polyurethane material. Alternatively, a chemical thickener such as diethylene triamine may be utilized. As the thickened polyurethane material cures, there is essentially no loss of volume. Thus, important cushioned bridging support is provided between floor boards and any uneven depressed portions of the supporting base.

The final floor may be rolled to force the floorboards into uniform intimate contact with the adhesive prior to the curing of the adhesive. Additionally, a concrete primer, such as silane, may be used to improve the grip between the polyurethane material and the concrete supporting base.

Further expense of the flooring system is minimized by the ability of the system to utilize short lengths of wood, normally less than six inches. Also, relatively thin floor boards may be used, normally not in excess of five sixteenths inch in thickness. The boards may be set in any desired pattern, including a parquet configuration. The width of the wood boards may be as desired, and the least expensive widths can be used in the present invention.

In a preferred embodiment, the floor boards are approximately five and one-half inches long, five-sixteenths inch thick, and approximately fifteen - sixteenths inches wide. As an alternative other wood flooring members such as plywood sheets, wood chipboard, nine by nine inch by one-half inch thick plywood flooring tiles, or the like, could be used. The polyurethane material, after it cures, is approximately 1/16" thick and the floor system provides both impact and air-borne sound deadening as well as resilient cushioning.

For the purpose of illustrating the invention, there is shown in the drawing an embodiment which is presently preferred. It should be understood, however, that this invention is not limited to the precise arrangements shown.

In the drawing:

Figure 1 is a partial perspective view of a flooring system constructed in accordance with the present invention;

Figure 2 is a section view taken along lines 2-2 of Figure 1; and

Figure 3 is a partial perspective view showing the preferred configuration of adhesive applied to the base or subfloor.

Referring now to the drawing in detail there is shown in Figures 1-3 a floor system generally indicated by the reference numeral 10. The system is applied over a subfloor or supporting base 12 which may be concrete, wood, or the like.

A trowelled layer of a polyurethane adhesive material 14 which is elastomeric when cured is applied to the subfloor 12. When applied to the subfloor, the trowelled layer preferably has spaced ridges with the width of the ridges at the base being approximately three-sixteenths inch. The height of ridge 16 is approximately one-quarter inch. There are gaps of three-sixteenths inch between adjacent ridges 16 and 18 and between each of the adjacent ridges.

The polyurethane material, after mixing of the two components, is brought to a trowellable consistency by the addition of approximately two parts by volume of powdered silicon dioxide thereto, so that the material is changed from a flowable liquid to a trowellable mastic consistency. The polyurethane material has an approximate tensile strength of 200 p.s.i., a 10% compression modulus of less than approximately 90 p.s.i., and a durometer Shore A-2 gauge hardness of approximately 35 to 55.

After the ridges of material 14 are applied, the floor boards 20 are pressed into the material 14. The ridges are crushed by pressure applied to the upper face of the boards to ensure maximum contact with the bottom face of the boards and to force the adhesive material into a substantially uniform predetermined thickness between the floor boards and the supporting base. As the adhesive material 14 cures, it provides an adhesive and cohesive resilient cushioning elastomeric layer between the floor boards and the base 12. The material 14, when cured, has high gripping and tensile strength. Warping, cupping, lateral or vertical buckling movement, or other distortions of the floor boards as a result of adverse moisture conditions are

substantially eliminated.

The flooring boards 20 may be installed in a parquet pattern. The boards may be placed in a tight abutting relationship and pressed into the material 14 in order to create a tightly jointed resiliently cushioned adhesive-applied wood flooring system.

The material 14 may be a two-component cellular or non-cellular filled polyurethane material. An acceptable material is Versaturf " 360 " marketed by Powerlock Systems, Inc.

The flooring boards may be any conventional type board, normally of oak or maple, and may, in fact, comprise the least expensive floor boards available since the invention works especially well with short thin floorboards.

WHAT I CLAIM IS:—

1. A method of installing a restricted-growth resilient cushioned adhesive-applied wood flooring system over a supporting base comprising the steps of:

coating the base and/or the bottom surfaces of wooden flooring members having top and bottom surfaces and side edges with an adhesive material which is elastomeric when cured;

pressing said wooden members on to the base with the adhesive material therebetween to form a wood/adhesive material/base material sandwich with just two interfaces and with said adhesive material contacting substantially the entire bottom surface of the wooden members;

and permitting the adhesive material to cure to a condition wherein it forms a resilient cushioning elastomeric bond between the wooden members and the base and has sufficient gripping and tensile strength to overcome potential buckling forces generated within said wooden members as a result of adverse moisture conditions without sacrificing the cushioning properties of the system, as laid.

2. A method of installing a restricted-growth resiliently cushioned wood flooring system according to claim 1 wherein said curable adhesive material is a two-component polyurethane and wherein the wooden members are placed such that the side edges of each wooden member substantially contact the side edges of adjacent wooden members.

3. A method of installing a wood flooring system according to claim 2 wherein said polyurethane has a tensile strength of approximately 200 p.s.i., a 10% compression modulus of less than approximately 90 p.s.i., and a durometer Shore A-2 gauge hardness of approximately 35 to 55.

4. A method of installing a restricted-growth resiliently cushioned wood flooring system according to claim 2 or 3 wherein said polyurethane has added powdered filler material and wherein the base is coated by trowelling the adhesive material on to the base in a ridged pattern.

5. A restricted - growth resiliently cushioned adhesive-applied wood flooring system installed by a method as claimed in any one of claims 1 to 4, the flooring system comprising a supporting base, wooden flooring members, and an elastomeric resilient cushioning adhesive material between said base and said wooden flooring members, said wooden flooring members being spaced from said base by said adhesive material, said wooden members each having side edges, a top surface and a bottom surface, said wooden members being elastomerically bonded into said adhesive material with said material contacting substantially all the base and the bottom surfaces of said wooden members, said adhesive material having sufficient gripping and tensile strength to overcome potential buckling forces generated within said wood flooring system as a result of adverse moisture conditions without sacrificing the cushioning properties of the system as laid.

6. A restricted - growth resiliently cushioned wood flooring system according to claim 5 wherein said adhesive material is a two-component polyurethane.

7. A restricted - growth resiliently cushioned wood flooring system according to claim 6 wherein said polyurethane has a tensile strength of approximately 200 p.s.i., a 10% compression modulus of less than approximately 90 p.s.i., and a durometer Shore A-2 gauge hardness of approximately 35 to 55.

8. A restricted - growth resiliently cushioned wood flooring system according to claim 6 or 7 wherein said polyurethane has added powdered filler material.

9. A method as claimed in claim 1 substantially as hereinbefore described with reference to the accompanying drawing.

10. A restricted - growth resiliently cushioned wood flooring system substantially as hereinbefore described with reference to the accompanying drawing.

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1558408 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

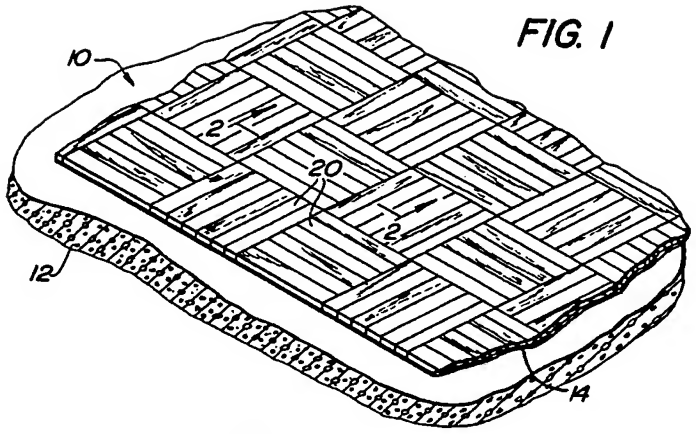

FIG. 1

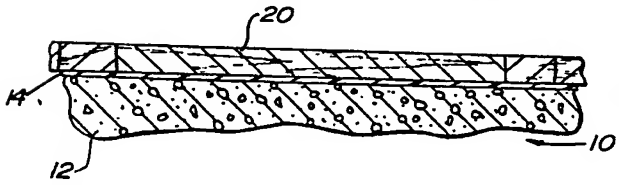

FIG. 2

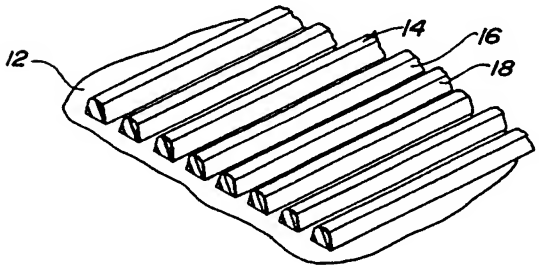

FIG. 3